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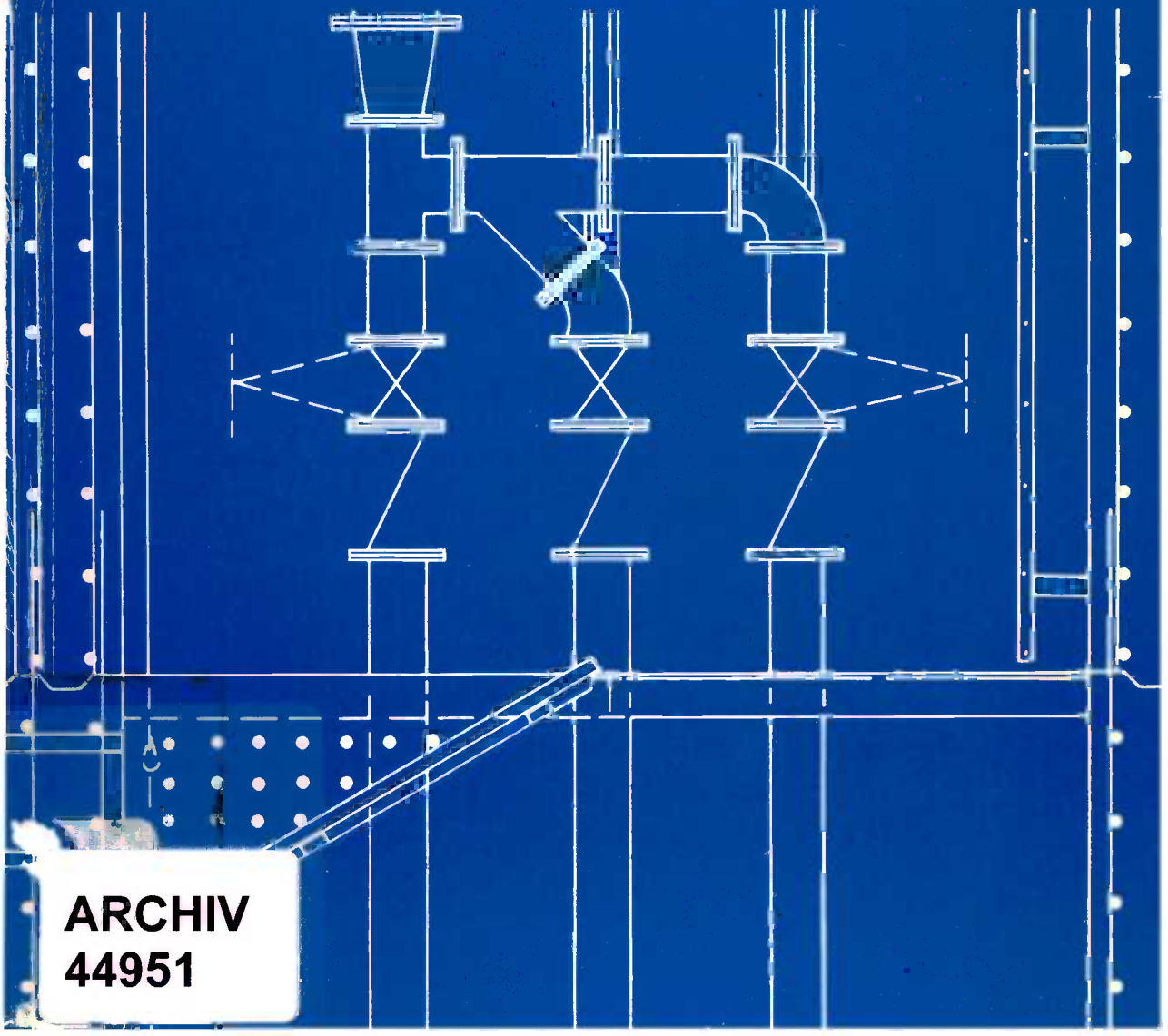
Consulting and Engineering Design in Developing Countries

Edited by Alberto Aráoz



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EDITED BY ALBERTO ARÁOZ

CONTENTS

CHAPTER 6

CASE STUDY OF A CONSULTING AND DESIGN ORGANIZATION IN ARGENTINA

LUIS STUHLMAN, WITH COLLABORATION FROM
BIBIANA DEL BRUTTO

SUMMARY

ABC is a medium-sized firm engaged in the engineering and construction of civil and industrial projects. It was founded in 1951 and worked on installation and construction activities for several years, after which it gradually created an engineering capacity, which today is relatively substantial. ABC now employs about 600 permanent staff of whom 140 are engineers and other professionals; it also engages a fluctuating labour force engaged in construction and installation activities of some 1500 persons on average.

ABC grew through successive assignments of increasing size and complexity for state and private clients, progressing from a small construction and installation firm to a complex organization, in a not too favourable environment and with no special help from government policy. Four stages can be identified: (1) during the 1950s a succession of small and sometimes medium-sized jobs was done for electrical companies and industry; (2) in the 1960s there were diversification and growth. Projects were larger; clients were in a wider spectrum of branches, notably railways, telephone, gas, and electricity. The technical office, however, was small; the firm's business was not engineering design but project execution and local purchasing services. A deep crisis was weathered in the mid-1960s when public investment decreased substantially; (3) in the early 1970s, the rate of growth increased, and there was more diversification. The firm entered into industrial projects and started to do some process engineering when it won two bids for simple process plants (peripheral to existing plants). (4) In 1975 ABC joined other larger firms in an engineering consortium for a technologically complex sector. It then needed to build up a strong engineering capability, ahead of likely contracts (rather than line up technical help after getting a job, as tended to be the case earlier on). A sizable engineering department was rapidly formed, with 120 staff members (70 engineers) in 1976; the team that had been working on the two projects mentioned above constituted the basis for the new engineering department. At the same time, the management cadre was expanded, several experienced professionals being brought in, and the management style itself underwent a significant change: the shop became a true enterprise. Forward planning was introduced. A decision was made to hire 10 young professionals and train them for several years (although this has had to be postponed for the time being). Numerous proposals were drafted, and the firm entered a number of bids, primarily to gain experience (from its work and from the comparisons with competitors' offers) and also as a means of getting to be widely known.

More recently, the firm experienced severe setbacks when several projects on which it counted, or which had been successfully bid, did not materialize for various reasons. At the same time, public investment has slackened, and the firm

has been facing a deteriorating situation at a moment when it has to support much higher fixed costs on account of the large, expensive engineering department.

A number of interesting points may be mentioned: (1) the struggle to survive and grow may be seen from the variety of fields of the recent projects for which bids were successfully entered, to wit: (a) part of detailed engineering and construction of a large hydroelectric plant; (b) detailed engineering and construction of a petroleum refinery; (c) same for rail electrification; (d) same for telecommunications network; (e) same for copper rolling mill. All of these projects except the first one were to be done in collaboration with a foreign firm; (2) this wide variety — covering a large spectrum of C&E activities, as well as many unrelated branches — probably reflects the facts of life in ABC's environment in Argentina, where the largest client is the public sector, with large fluctuations in its demand; each branch is a relatively small market for C&E and construction services, and there is stiff competition from other CEDOs and contractors; (3) the main technical decisions are normally made by the client, which is usually a large public enterprise with a certain amount of C&E in-house capability. The outside engineering firm does not participate closely in the preinvestment stage but is brought in to engineer and implement the resulting decisions; it complements, but does not take the place of, the client's own C&E capacity. In fact, the client is bound to have a larger and more sophisticated capability than the local CEDO, which is really a constructor for which engineering is somewhat of an excuse to win a bid and obtain a contract. It is in construction that profits are made, not in engineering; and (4) like other engineer–contractors and consulting firms, ABC has almost no connections with the local science and technology system and does not carry out technical development work. Its access to technical information is through the technical literature, frequent trips overseas, participation in technical meetings, temporary association with foreign CEDOs, and very importantly the hiring of experienced professionals including university teachers.

The history of engineering firms in developing countries is shorter than in the industrialized countries, extending for not more than 40–50 years. In Argentina, there were a few sizable engineering firms before the 1950s; these were engaged in public works construction, usually in a subordinate position to foreign firms. During the 1950s several events took place that helped the appearance of local CEDOs:

- The availability of an important number of well-trained engineers;
- The impetus given to infrastructure development plans: water resources development, railway improvement, ports, roads, etc., sometimes with the support of the World Bank; toward the end of the decade there was a large effort in petroleum exploitation, and large direct foreign investments were made in automobiles and other branches;
- The increasing links with the international financial agencies, which led to the setting up of a planning mechanism that channeled outside financial resources; those agencies, at the same time, demanded technoeconomic studies to justify project feasibility — a requirement that boosted C&E services (IBRD 1974); and
- The influence of U.S. consulting and engineering in the postwar years; C&E services were imported from that country, as well as an

organizational pattern for engineering firms (Perichitch 1978). This pattern affected Argentina in three ways: many foreign engineering firms came for an isolated project; a few installed themselves permanently, particularly in the early 1960s, originally bringing foreign personnel, who were gradually replaced by local people (this sometimes happened in response to a continuing demand by the public sector or foreign enterprises, which could be satisfied by cheaper local engineering personnel of good quality); and more importantly, local engineering firms developed, from different origins but tending to adopt the U.S. pattern of an engineering firm, an autonomous entity, separated from production, with differentiated services of the staff type.

During this period, groups of professionals who were not tied to production began to act as advisers in the solution of diverse problems. They used a set of techniques, some of them sophisticated (operational research, CPM, etc.) that could be applied to different fields for the improvement and modification of design. The organizational model — groups of advisers acting autonomously — was transferred to Argentina and its new engineering firms.

Toward the end of the 1950s and the beginning of the 1960s a number of local engineering firms came into being. Civil, electrical, and mechanical engineers were the first to find a place in this type of activity, and these specializations are still more developed today than others. In the 1960s, with the military government's emphasis on planning and on infrastructure, other consulting areas grew, such as those devoted to economics (economic analysis and profitability estimates to evaluate projects and define investment priorities), sociology, and mathematics, with a tendency toward the integration of interdisciplinary groups. Some state organizations, such as those in charge of roads and hydroelectricity (Dirección de Vialidad and Agua y Energía Eléctrica respectively), accelerated the process through their increasing demand for C&E services, as did other state enterprises later when building their plants.

In the 1970s, ups and downs in the country's economic and institutional situation particularly affected engineering firms. One prime reason is the ways these firms came into being, what may be termed their mode of emergence (EM), which strongly influences development of a firm, the characteristics it acquires, and the policies that may promote its development. The common modes of emergence are:

- Branching off — a large foreign firm making its services available to others, similar to the process taking place in multinational enterprises.
- Differentiation and increasing complexity — the most frequent case being engineering firms in civil construction that took up process engineering, perhaps in two or three stages; this is related to another mode of emergence, differentiation and growth;
- Organizational autonomization — engineering departments that become true engineering firms, using fresh opportunities of profiting from their accumulated experience and their infrastructure; sometimes this takes place in harmony with the mother firm, which keeps links with, and gives backing to, the more autonomous engineering department; in other cases some degree of conflict is involved in the process of gaining autonomy;

- Development, through necessity, of complementary services — engineering firms originating from equipment makers, which to increase their output and sales need to give their customers a growing technical support and end up discovering they have a technical structure able to provide engineering services that are profitable per se in addition to increasing sales capability;
- Segmentative — a branching off from process engineering firms taking place after process engineering consultancy has achieved a sufficient degree of institutionalization (i.e., a group branches off from an engineering firm to form a new engineering firm); in Argentina there is only one case of this among the process engineering firms;
- Organizational creation — several engineers deciding to create a process engineering firm; frequently the partners have spent a long time abroad and have acquired the necessary experience, which they then capitalize.

A survey of engineering firms in Argentina (Suárez and Stuhlman 1975), has shown the percentages of firms that have emerged by branching off (11%), differentiation and increasing complexity (22%), differentiation with increasing complexity and growth (22%), organizational autonomization (15%), complementation of services (5%), and organizational creation (25%). The most recent mode of emergence, organizational creation, accounts for one-fourth — a figure showing the increasing process of institutionalization of the type of activity. Although stable branching off represents only 11%, other foreign engineering firms continuously appear in the market to bid for large contracts; though nowadays they must associate with a local firm.

The process engineering firm that is the subject of this study, the ABC Company, may be classified within the mode of emergence "differentiation with increasing complexity and growth," with the virtues as well as the limitations of this style. The firm complies with the criteria set forth in chapter 2: it serves the process industries and has been engaged in a medium-sized investment project. Unfortunately, we were unable to gather sufficient data to provide an analysis of the project.

ABC was founded in 1951 (under a different name) by a group of engineers, as a limited liability company. The CEDO was initially created to take up diesel engine repairs, and later their installation, together with ancillary elements, in electric power plants. There were five partners originally; three of them have remained to this day and are the firm's owners.

One of the original partners had been the president of a large state enterprise. Another, an electrical and mechanical engineer, had studied and worked in European countries and had some experience locally in planning, feasibility studies, and projects in electrical installations. A third partner was a civil and hydraulic engineer with some experience in the public service. A fourth partner had a degree in aeronautical engineering, had worked for the Transport Ministry, gathered experience through a stay in Europe, and had been technical manager of a firm engaged in mechanical work.

Some important points in the firm's evolution were:

- The first assignment was a high-tension transmission line, for which it had to subcontract another engineering firm to complement its capabilities.

- In 1957 the firm split into three, one of which became ABC. At that time there was a strong interest in expanding the field of action and consolidating the experience as contractors to the state.
- In 1961 ABC became a corporation: "at that moment we understood that we also had to become an engineering company. . . . This needed our development in the electromechanical area: project design, procurement, installation, tests, start-up, sometimes even supervision and technical management, [we were] trying if possible to reach the turnkey stage." During this period the firm built a complete power plant, including high-tension lines, fuel deposits, buildings, installation of a 4550 kW group, cooling tower, etc.
- The most important project in the early 1960s was a power plant for a large state enterprise, including the civil and the electromechanical components (two turbogroups of 10 000 kW each).
- In the late 1960s, faced with a decline in public investment, ABC diversified. However, at the end of the decade an important assignment was undertaken for procurement services and installation of a 132 kV line, 138 km long, with transformer substations. Laying this line was a complex task, which needed numerous special solutions that enriched considerably the company's technical knowledge. During this period ABC also started to work on industrial projects.
- An interesting milestone was a high-tension line in 1970. ABC prepared the projects for supply and installation, but because the towers were steel, ABC engineers were placed in the firm that manufactured them, so that this became an instance of local supplier development through the technical support of the engineering firm.
- The first half of the 1970s showed an important quantitative and qualitative growth of the firm (Table 13). In spite of the ups and downs of the economy and the virtual freezing of public works in 1971, the first two large (for ABC) industrial projects took place: an asphalt blowing plant and a paraffin treating unit.
- Another element characterizing ABC's growth and development in this period was its association with the large CEDOs that operated locally, which until then had formed a closed circle of three firms that shared the large projects among themselves. In 1973 ABC joined one of the large CEDOs in a bid for a high-tension line. In the second part of the decade ABC won, in association with one of the large firms, the high-tension line for a large hydroelectric project, and together with the same associate and another of the large firms, it won the bid for an important communications network.
- A more important indicator of development was the inclusion of ABC as an associate in an engineering consortium for the engineering and installation of atomic power plants. This consortium is made up by the five largest construction and engineering firms in the country. ABC participates with 17% of the capital.

When this study was made (late 1978), the CEDO was going through a critical stage of growth and consolidation of its structure. A new organizational structure and a different policy toward human resources would mean large expenses, particularly a very high payroll (U.S. $8 million a year for the engineering departments only), which the firm could not afford.

Table 13. Projects executed by ABC.

Period	Percent of total
1954–58	9.3
1959–63	7.9
1964–68	15.1
1969–73	24.5
1974–78	43.2

Table 14. ABC's role in 139 projects between 1954 and 1978.

Role	% of Projects
Project design	52
Procurement services	52
Installation	100
Supervision	26
Start-up	64
Study	17
Maintenance and repairs	15

The firm's aim is "to be able to carry out all types of industrial projects," in the words of one of its directors. The goal of progressing from engine repair and electrical installation to the design and execution of large industrial projects has been met in part. The achievement is indicated by the projects in hand in late 1978: procurement services, installation, start-up, and commercial exploitation of seven mobile power stations; project design, construction, and commissioning of several high-tension transmission lines; auxiliary systems (lubrication oil, compressed air) for a large hydroelectric plant; signal system for a subway line; procurement services, installation, and start-up of several telecommunications centres; detailed engineering, complement of process engineering, procurement services, construction, installation, and start-up of a waste liquid treatment plant; installation of a pit furnace for the heating of special steel; assembly and installation of belt transport equipment; and electrical and mechanical installation for a foundry.

Even though the CEDO now offers a wide range of services, it started as an installation firm, and its most important activity is still installation, although projects now offered include industrial plants in the petroleum and petrochemical sectors; industrial plants in other sectors; transmission lines, networks, power plants, substations; networks for the distribution of gas and water; railway networks; and civil works. The services supplied by ABC in each case have been engineering (usually detailed); construction and installation; procurement; start-up; prefeasibility; maintenance and repairs.

The firm states it can study, design, plan, supervise, and execute any type of industrial project. Its involvement goes from the project's feasibility study to turnkey delivery, including all the intermediate stages such as project design, procurement, installation and assembly, tests according to national and international standards, and training of specialized personnel.

Role of the Firm

The ABC company carried out 139 projects since its inception. In all of them the firm was in charge of construction and installation (Table 14–17). Most projects (43%) were carried out during 1974–78, ABC gaining prestige in the internal market since 1970.

Table 15. Type of project according to ABC's role.

Type of project	Role of ABC (% control)						
	Project design	Procurement services	Installation	Supervision	Start-up	Study	Maintenance, repairs
High-tension networks	60	65	100	13	–	12	33
Petroleum/ petrochemicals	75	65	100	30	40	25	–
Industrial plants	50	15	100	62	58	27	–
Railway system	50	25	100	50	–	50	–
Civil works	43	14	100	43	–	–	–
Communications	100	33	100	66	–	–	–
Gas networks	–	66	100	6	–	–	–
Other	40	20	100	–	20	20	–

Table 16. Proportions (% of total projects) represented by different types by period.

Period	Electric projects	Petroleum, petrochemicals	Industrial plants	Gas networks	Civil works	Other
1954–58	41	16	–	43	–	–
1959–63	86	14	–	–	–	–
1964–68	66	–	6	–	13	15
1969–73	65	11	14	9	–	1
1974–78	36	10	17	22	12	3

Table 17. Value (% of total value for each type) of project, by period. [a]

Period	Electric projects	Petroleum, petrochemicals	Industrial plants	Gas networks	Civil works	Other
1954–58	1.4	2.3	–	3.2	–	–
1959–63	4.7	3.2	–	–	–	–
1964–68	5.5	–	1.1	–	4.7	15.6
1969–73	28.4	15.5	12.3	7.5	–	5.5
1974–78	60.0	79.0	86.6	89.3	95.3	78.9

[a]Before calculation of percentages, the value of projects was converted to U.S. dollars at the mid-period rate of exchange.

In the first period, 1954–58, the firm supplied procurement services in most projects, but only in half of them did it carry out the engineering project design. In the following stage (1959–63), the firm provided a greater proportion of supervision services. In the last period, there has been an increase in the proportions of project engineering and start-up, both of which are technologically complex; a significant proportion of projects have included preliminary studies (consulting).

Increasingly since 1970, ABC has provided all services for its projects. The principal source of income has been electrical projects, and this focus has been a reflection of market demand, especially by the state. During the last few years ABC has become more involved in industrial projects and less so in petroleum, petrochemical projects and electric and gas networks.

Policies of the Firm

Human Resources

A survey of ABC's professional staff showed that in 1975 58% were between 30 and 39 years old (2% under 30, 21% 40–49 years, and 19% over 50); professionals included civil engineers, builders, and architects (37%); electrical and mechanical engineers (electromechanical 16%, electrical 5%, and mechanical 25%); and other engineering specializations (17%). Formal training after graduation was low: 53% had not taken any courses and 41% had taken postgraduate courses. 60% had worked previously in local private firms, 42% in foreign-owned private enterprises, and only 24% in public administration; 48% had worked in engineering firms, 18% in foreign-owned engineering firms; 44% had worked in engineering departments. At the time of the survey, 35% had teaching activities.

Although the human resources were substantial, as ABC continued to grow and have prospects of more complex and larger assignments, it required higher technical and management skills. Thus, in 1977, it drafted an ambitious plan for managing and training its human resources.

Two aspects of this plan are of special interest. First, developing human resources meant modifying the firm's management structure. Thus, in early 1978, the firm recruited a general projects manager and two projects managers (who came from firms operating in the local engineering and installation market), a supplies manager (from another CEDO), an engineering manager (an Argentine previously working as engineering manager of a Brazilian CEDO several times larger than ABC), and six other professionals (previously in responsible positions in Brazil). In this way, ABC obtained a very good management team, through high remunerations and improved its image in the market as a growing and developing company. Second, a large sum was allocated for a special recruitment and development program to search for and train a group of 10 engineers, of high promise. The 5-year program called for training overseas, in CEDOs, industrial enterprises, R&D institutions, etc., and would produce a technological reserve for ABC. Although the program has been delayed on account of the current economic difficulties of the firm, it has not been abandoned, and high hopes are attached to it.

In 1978, the firm's total personnel, including manual workers, numbered in the thousands, 585 being permanent salaried personnel (Table 18).

Relations with Users

Suárez and Stuhlman (1975) commented on process engineering firms and the forms of association among these firms as a basic commercial strategy. They found that firms of similar size and prestige seldom compete with one another to provide services locally, although they may compete for foreign markets. The exceptions are medium-sized firms, which sometimes form associations but frequently maintain competitive relations.

The large firms, which have adequate marketing strategies, share risks. The size of their staffs means high fixed costs, which they balance by sharing the work load among themselves. Hence, in a not too covert manner, they decide which one of them will take up a certain job, basing the decision on available personnel, relative regional advantages, etc. This strategy allows them to control the market of large jobs that demand a good track record and experience that only these firms have. The lack of competition is clearly perceived by small and medium firms, which complain: "This is an unpredictable market for us but not for the large installation firms, which always associate among themselves. There is no legislation protecting us against this."

Medium-sized firms, reflecting a traditional tendency of small and medium enterprises toward isolation, do not generally adopt a strategy of cooperation; they compete for projects that, on account of their volume, are of no interest to the large firms. They have only occasionally entered into association.

The strategies of small firms are more varied. They scarcely compete among themselves, or with others, but the forms of cooperation that they use or propose are diverse. One frequent practice is to carry out specific

Table 18. ABC's permanent salaried staff in 1978.

Office	Engineers	Other professionals	Non-professionals
General manager	1	–	1
Finances	–	2	42
Administration	–	3	29
Human resources	–	1	21
Advisory (legal, audit, taxes, control, costs)	2	3	11
Sales	4	–	5
Commercial	1	–	3
Contracts	2	1	3
Technical	1	–	1
Construction	36	5	91
Industrial works	31	1	80
Procurement	2	2	62
Engineering	36	9	93

chemical engineering tasks for local large and medium firms. In other cases they prefer to associate with other small firms, usually:

- To complement services and help each other in surviving; the modest aim is not to disappear from the market; and
- To associate with foreign firms to learn the trade and increase the possibilities of winning bids; if an association is formed, the firm usually shares its work with other small firms.

ABC has established links with foreign firms for certain jobs — at first, with English, French, and U.S. firms, for electrical and installation works. It has preferred occasional associations because more permanent arrangements, according to an ABC official, are: "not convenient in Argentina, since currently the process is chosen by the client, not the engineering firm." ABC has favoured occasional associations, both with foreign suppliers of equipment and with local engineering and installation firms, to lower risks and even out the work load. For example, in 1971, it joined SULZER (Switzerland) for the engineering, construction, and installation of a compressed air plant for a large state enterprise, SULZER manufacturing the equipment locally; in 1972, it formed ties with a large local firm for a 220-kV line; in 1975, with a large local firm for a 33-kV line and the start-up of imported equipment for the railways; and in 1977, with a French firm that supplied rail equipment.

The preferred commercial strategy is association rather than direct competition, which was possible only when ABC reached a level where it could compete with other large local firms. The firm has its own financial resources, through a financial company it owns; in large jobs it associates with banking groups that organize the financial package, which is then submitted to the client. In most cases, the contract with the user is through bids, as the user is usually in the public sector (Table 19).

Regarding foreign users, ABC has adopted an interesting commercial and technical approach. The fluctuating government policy on nontraditional exports has brought about insecurity and difficulties in the export of engineering services. However, ABC has systematically submitted bids on international projects, even though the chances for winning the contract were slim. This was done for two reasons: to gather experience on adapting to the rhythm, deadlines, and quality of presentation required by international practice; and to be able to examine the proposals presented by foreign firms.

Table 19. Percentage of ABC projects according to user.

Period	State enterprise	Private enterprise	Public administration
1954–58	83.3	–	16.7
1959–63	72.7	9.1	18.2
1964–68	47.6	–	52.4
1969–73	73.5	–	26.5
1974–78	88.2	3.9	7.9

Technological Policy

Relation with Technology

A CEDO, as any other organization, requires technological inputs to transform them into services. Although the technological management of a CEDO appears to be restricted to the least complex aspects of engineering technology, because of the nature of relations proposed by the user, who chooses the technology to be employed, there has been a good deal of technical progress on the part of ABC. Since the early days of electromechanical installations, the firm has evolved considerably. Today it is participating in nuclear power plants, having progressed from a small project office to a Department of Engineering. Though the firm does not have a central technical file, depending rather on personal files, it is studying the convenience (already perceived) of having a central file with up-to-date technical information.

To the extent that a wider role is expected in the future, the firm wishes to develop its links with the technology-producing system, which would allow it to produce basic engineering. This aspect, however, is more declarative than real in Argentina (with perhaps only one exception, TECNOR), because this is not the heart of the business. In any case, ABC has generated one stable link of this type. An agreement has been signed with an Italian firm for projects in petroleum, petrochemicals, cement, and pharmaceuticals; bids would be presented jointly, the foreign firm supplying technology of its own and basic engineering, and ABC supplying detailed engineering, construction, procurement services, installation, and start-up. In this way, a new role has opened up – that of offering turnkey plants, instead of receiving orders somewhat passively.

Relation with the Local Science and Technology System

"Engineering firms emerging through branching-off, or by increasing complexity and growth, have no awareness of the local S&T system, and only get to the point of perceiving university centres, which they regard as academic and not too useful," according to Suárez and Stuhlman (1975). The position of ABC should be seen within this frame. Its perception of the local system is as stated by Suárez and Stuhlman (1975): "We have no links because the system is too isolated. It would be interesting to get connected, but truly this would not be too useful for us, save perhaps with the Atomic Energy Commission."

Forms of Access to Technical Information

The most usual ways in which engineering firms keep up-to-date technically are reviews, 69%; trips abroad, 46%; head office, 16%; congresses, 16%; courses, 16%; and university teaching, 16% (Suárez and Stuhlman 1975). ABC employs several of these resources. It has subscriptions to about 15 international reviews. Frequently, staff travel to the U.S., Europe, and Japan. Some information comes from meetings of the Argentine Petrochemical Institute (where at the same time commercial contacts are made). But probably the most important method for updating is the recruitment of university teachers (who account for one-third of the professionals) as well as the later identification of new human resources (outstanding students).

Export of Services

ABC has tried to export its services, particularly in high-tension lines and telecommunications systems. The company has entered several bids in recent years, in Bolivia, Paraguay, Uruguay, and Ecuador, but has not won any of them.

Handling of the Context

The state influence on ABC is decisive because it is almost the sole client. The firm tries to influence investment policy, legislation on price adjustment, and other regulatory aspects, so that they become favourable. CEDOs of relatively large size, like ABC, join forces in the Argentine Chamber of Construction, whereas the small CEDOs do so in the Argentine Chamber of Consultants.

An institutional publicity campaign was started in 1976, through a prestigious and sophisticated agency. Advertisements are regularly published showing ABC's achievements. Sponsorship was given to the junior Chamber for its prize to the Ten Outstanding Young Persons in 1977.

Achievements

Organization of Work

The CEDO has a general organization for the enterprise and a different one for its Engineering Department (since 1978). This department has begun to be structured in matrix form, like the large U.S. CEDOs, with task forces whenever necessary (in general, however, task forces are avoided because they are considered to be expensive; they are employed only as a last resource).

The CEDO has had internal problems (not with its users) on account of the quality of its detailed engineering, the persons in charge of construction being forced to solve too many questions on the spot (it must be remembered that ABC started as a construction and not as an engineering firm). The problem (says the firm) is faced by all CEDOs that carry out both construction and engineering. To overcome it, the firm made an interesting innovation. As was explained by one of the Engineering Department managers, "usually the man designing the project does not know whether the man in the building site has trucks or tractors, or how much manpower is available with what skills. You cannot expect the man at the drawing board to have familiarity with construction activity. A solution we have employed is to bring people from the building site to design the projects. But this is no good; they are men with their own tricks, and very empirical. The solution is coparticipation. This is the experience we are getting, with excellent results. Those from the construction side of the firm come and work with us when the project is about 30–40% advanced, and then, when the project is to be built, they know it well. Also, groups of engineers install themselves permanently at the construction site. We have obtained in this way more rapid communication, technological improvements, and a reduction in costs."

Daily work routines are based on the circulation of documents that must be checked and signed by those responsible for the different specializations. The firm has a library in the Engineering Department, and

data processing facilities for technical calculations, material specifications, and project planning and control. The programing of tasks is done both by manual PERT and by computer processes.

The normal routine of work, once a contract has been signed, is:

- One person is given global responsibility for the contract;
- Another person is assigned to be responsible for the project, and also a planner, to estimate total engineering hours, according to the number of documents to be prepared;
- Personnel requirements are estimated; a team is outlined; times for the different tasks are estimated; and the first provisional GANTT chart is prepared;
- The task is divided into what will be supplied by the user, the CEDO, and outsiders;
- Each document that is prepared goes to the filing section, which is responsible for its handling;
- At a certain moment the procedure starts to be handled by Supplies, which gives the data from Engineering to the vendor and from the vendor to Engineering;
- The set of documents is sent to the user for approval;
- When the documents are returned, modifications are incorporated or discussed; documents then go to the checkers (specialists in each task) for quality control; and
- Once approved, documents go to the building site.

The Success of ABC

The great success of the CEDO is eminently economic and is shown by the enormous growth of sales in the 25 years since its foundation. This, according to the firm's managers, is due to a very dynamic handling of the enterprise, good commercial contacts, good economic decisions at the right moment, and a continuous improvement in the technical level.

In terms of impact on the context, rather than of enterprise growth, the firm has had some influence on the development of equipment suppliers and has repatriated an important group of Argentine professionals that had emigrated for lack of opportunities. But, at least up to the present, ABC has not had a significant impact on autonomous technological development. This is probably due more to the nature and modalities of the Argentine environment than to the vocation of the CEDO itself. Indeed, in Argentina the large users have their own engineering capability, which is employed as internal consultancy for investment projects, and can then purchase technology and basic engineering abroad, allowing the CEDO only the role of builder and installer.

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